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MERCHANT & GOULD PC
P.O. BOX 2903
MINNEAPOLIS, MN 55402-0903

EXAMINER	
THANGAVELU, KANDASAMY	

ART UNIT	PAPER NUMBER
2123	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/806,183	LAURENT-CHATENET ET AL.	
	Examiner	Art Unit	
	Kandasamy Thangavelu	2123	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *24 May 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-23* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 May 2001* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☒ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

1. Claims 1-23 of the application have been examined.

Foreign Priority

2. Acknowledgment is made of applicants' claim for foreign priority based on applications 9813090 filed on October 15, 1998 and 9900304 filed on January 11, 1999 in France. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Information Disclosure Statement

3. Acknowledgment is made of the information disclosure statement filed on March 28, 2001 together with copies of the papers. The patents and papers have been considered in reviewing the claims.

Drawings

4. The drawings are objected to; see a copy of Form PTO-948 for an explanation.

Claim Objections

5. The following is a quotation of 37 C.F.R § 1.75 (d)(1):

> The claim or claims must conform to the invention as set forth in the remainder of the specification and terms and phrases in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description.

6. Claims 2, 3, 6, 7, 13, 15, 21 and 23 are objected to because the plurality of elements or steps are separated by bullets. 37 CFR Rule 75 (i) states that when a claim sets forth a plurality of elements or steps, each element or step of the claim should be separated by a line indentation.

7. Claims 1-22 are objected to because of the following informalities:

Claim 1, Line 9, "said step of decimation by merger of a edge" appears to be incorrect and it appears it should be "said step of decimation by merger of an edge".

Amended claim 10, Line 7, "said step of decimation by merger of a edge" appears to be incorrect and it appears it should be "said step of decimation by merger of an edge".

Claim 11, Lines 5-6, "characterized in that, each of said meshes being defined by the position of each of its vertices, said minimizing step provides" appears to be incorrect and it appears it should be "characterized in that, for each of said meshes being defined by the position of each of its vertices, said minimizing step provides".

Claim 22, Lines 1-9, "T_i conversion merging two vertices X_i and X_j of said simplified mesh M';

X_i^f the vertex of said simplified mesh M' resulting from said conversion;

$F(X_i^f)$ the faces of said simplified mesh M' neighboring the vertex X_i^f after said conversion;

V_M set of the vertices of said source mesh M belonging to the faces having been intersected during the computation of the orientation of the surfaces during said minimization" appears to be incorrect and it appears it should be "T_i being conversion merging two vertices X_i and X_j of said simplified mesh M';

X_i^f being the vertex of said simplified mesh M' resulting from said conversion;

$F(X_i^f)$ being the faces of said simplified mesh M' neighboring the vertex X_i^f after said conversion;

V_M being set of the vertices of said source mesh M belonging to the faces having been intersected during the computation of the orientation of the surfaces during said minimization".

Claims objected to but not specifically addressed are objected to based on their dependency to an objected claim.

Appropriate corrections are required.

Claim Rejections - 35 USC § 112

8. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

9. Claims 6 and 10-23 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 6 states, the information representing the geometrical dynamics belongs to the group comprising:

a mean of the surfaces of the faces neighboring the edge considered. It is not clear what the applicant meant by a mean of the surfaces of the faces neighboring the edge considered. A surface is an identifier of a geometric element similar to the terms vertex, edge etc. It is not possible to take a mean of an identifier. It is only possible to take a mean of a parameter associated with the surface. Therefore, the mean of the surfaces is not defined and is vague and indefinite.

Claim 10 recites the limitation "Method for the encoding of a source mesh (M) according to claim 9" in Line 1 of the claim. There is insufficient antecedent basis for this limitation in the claim. Claim 9 refers to "Method for the geometrical optimization of a source mesh" and not Method for the encoding of a source mesh (M).

Claim 11 recites the limitation "Method for the encoding of a source mesh according to claim 10" in Line 1 of the claim. Claim 10 recites the limitation "Method for the encoding of a source mesh (M) according to claim 9" in Line 1 of the claim. There is insufficient antecedent basis for this limitation in the claim. Claim 9 refers to "Method for the geometrical optimization of a source mesh" and not Method for the encoding of a source mesh (M).

Claims 12 to 22 recite the limitation "Method for the encoding of a source mesh according to claim 10" or according to claim 12, or 14 in Line 1 of the claim. Claim 10 recites

the limitation "Method for the encoding of a source mesh (M) according to claim 9" in Line 1 of the claim. There is insufficient antecedent basis for this limitation in the claim. Claim 9 refers to "Method for the geometrical optimization of a source mesh" and not Method for the encoding of a source mesh (M).

Claim 15 states, "the determining of the position of X_p^* of X_p of said mesh according to the relationship defined in the iteration k+1 by

$$X_p^{k+1} = X_p^k - \gamma_k H \ LE\ (X_p^k) / \| LE\ (X_p^k) \|$$

k varying from 0 to n-1 (with $n < N$) and γ_k being the step of said relationship". The variables H and L are not defined in the claim and are therefore vague and indefinite.

Claim 16 states, "since the surface is parametrized by u and v". The variables u and v are not defined in the claim and are therefore vague and indefinite.

Claim 23 recites the limitation "Application of the method for the encoding of a source mesh according to claim 1" in Line 1 of the claim. There is insufficient antecedent basis for this limitation in the claim. Claim 1 refers to "Method for the simplification of a source mesh M" and not Application of the method for the encoding of a source mesh.

Claims rejected but not specifically addressed are rejected based on their dependency on rejected claims.

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

11. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

12. Claims 1, 8-13 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Hoppe** (U.S. Patent 6,426,750) in view of **Gueziec** (U.S. Patent 6,275,233), and further in view of **Touma et al.** (U.S. Patent 6,167,159).

12.1 **Hoppe** teaches real-time geomorphs. Specifically, as per claim 1, **Hoppe** teaches Method for the simplification of a source mesh M formed by a plurality of surfaces (CL1, L49-57; CL8, L31-37);

defined by vertices, faces and orientations of these faces (CL16, L9-11; CL16, L1-3; CL16, L51-67);

the method implementing a step of decimation by edge merger, consisting of the association of an edge to be decimated, defined by two vertices (11, 12), with a single vertex (13) so as to obtain a simplified mesh M' (CL8, L31-37; CL8, L62-62);

characterized in that the method comprises a pseudo-optimizing step after the step of decimation by merger of a edge (CL8, L31-37; CL8, L62-62; CL3, L52-55; CL16, L39-42); and

so as to reduce the geometrical deviation between the source mesh M and the simplified mesh M' (CL8, L47-56).

Hoppe does not expressly teach positioning the vertex resulting from the merger as a function of a criterion taking account of a number of sharp edges around each of these two vertices forming the edge to be merged. **Gueziec** teaches positioning the vertex resulting from the merger such that volume associated with the edge prior to simplification will remain unaltered after simplification (CL14, L29-35), because as per **Hoppe** that will reduce the amount of error with respect to more detailed mesh (CL8, L48-49). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Gueziec** that included positioning the vertex resulting from the merger such that volume associated with the edge prior to simplification will remain unaltered after simplification. The artisan would have been motivated because that would reduce the amount of error with respect to more detailed mesh.

Hoppe does not expressly teach positioning the vertex resulting from the merger as a function of a criterion taking account of a number of sharp edges around each of these two vertices forming the edge to be merged. **Touma et al.** teaches representing topology of the mesh by the degrees of the vertices i.e., according to the number of sharp edges that are incident on each of the vertices (Abstract, L1-3; CL2, L18-21; CL5, L57-64), because the topology of the mesh may be reconstructed using only the topology list and it provides more effective

compression of triangle mesh objects than any other method (CL2, L26-30). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Touma et al.** that included positioning the vertex resulting from the merger as a function of a criterion taking account of a number of sharp edges around each of these two vertices forming the edge to be merged. The artisan would have been motivated because it would provide more effective compression of triangle mesh objects than any other method.

Per claims 8 and 9: **Hoppe** teaches that the method constitutes a step of initialization of a method of geometrical optimization of a mesh (CL1, L37-40; CL8, L5-9); and Method for the geometrical optimization of a source mesh comprising a step of initialization implementing the method of simplification according to claim 1 (CL1, L37-40; CL8, L5-9).

12.2 As per claim 10, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 9. **Hoppe** teaches representing a 3D object, the meshes being defined by a set of vertices, edges and/or faces (CL16, L9-11; CL16, L1-3; CL16, L51-67);

delivering a simplified mesh (M') corresponding to the source mesh (M), characterized in that it implements the method for the simplification of a source mesh (M) (CL8, L5-9);

representing a plurality of surfaces defined by vertices, faces and orientations of these faces (CL16, L9-11; CL16, L1-3; CL16, L51-67);

the method implementing a step of decimation by edge merger, consisting of the association of an edge to be decimated, defined by two vertices, with a single vertex so as to obtain a simplified mesh M' (CL8, L31-37; CL8, L62-62);

characterized in that the method comprises a pseudo-optimizing step after the step of decimation by merger of a edge (CL8, L31-37; CL8, L62-62; CL3, L52-55; CL16, L39-42); and

positioning the vertex resulting from the merger so as to reduce the geometrical deviation between the source mesh M and the simplified mesh M' (CL8, L47-56).

Hoppe does not expressly teach a step of minimization of a volume contained between the source mesh (M) and the simplified mesh (M'). **Gueziec** teaches a step of minimization of a volume contained between the source mesh (M) and the simplified mesh (M') (CL14, L29-35), because as per **Hoppe** that will reduce the amount of error with respect to more detailed mesh (CL8, L48-49). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Gueziec** that included a step of minimization of a volume contained between the source mesh (M) and the simplified mesh (M'). The artisan would have been motivated because that would reduce the amount of error with respect to more detailed mesh.

12.3 As per claim 11, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 10. **Hoppe** teaches each of the meshes being defined by the position of each of its vertices (CL8, L5-9; CL8, L62-65).

Hoppe does not expressly teach the minimizing step provides for the determining of the position of the vertices (X1, X2, ..., Xn) of the simplified mesh (M') minimizing the volume V(M, M') between the source mesh and the simplified mesh. **Gueziec** teaches the minimizing step provides for the determining of the position of the vertices (X1, X2, ..., Xn) of the simplified mesh (M') minimizing the volume V(M, M') between the source mesh and the simplified mesh (CL14, L29-35), because as per **Hoppe** that will reduce the amount of error with respect to more detailed mesh (CL8, L48-49). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Gueziec** that included the minimizing step provides for the determining of the position of the vertices (X1, X2, ..., Xn) of the simplified mesh (M') minimizing the volume V(M, M') between the source mesh and the simplified mesh. The artisan would have been motivated because that would reduce the amount of error with respect to more detailed mesh.

Per claim 12: **Hoppe** teaches that the minimizing step implements an iterative process progressively optimizing the positions of the vertices of the simplified mesh (M') (CL8, L5-9).

Per claim 13: **Hoppe** teaches that the iterative process is interrupted when at least one of the following stopping criteria is achieved a maximum number of iterations (CL8, 7-9; CL8, L34-37);

a difference between two successive shift vectors of the positions of the vertices that is below a predetermined threshold (ϵ) (CL8, L47-56).

Per claim 19: **Hoppe** teaches that the method implements a progressive encoding of the simplified mesh by decimation and local optimization (CL8, L7-9).

13. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Hoppe** (U.S. Patent 6,426,750) in view of **Gueziec** (U.S. Patent 6,275,233), and further in view of **Touma et al.** (U.S. Patent 6,167,159) and **Hoppe** (U.S. Patent 6,046,744).

13.1 As per claim 2, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 1.

Hoppe does not expressly teach the step of pseudo-optimization comprises a step of enumerating the sharp edges around the two vertices forming the edge to be merged and a step of positioning the resulting vertex, in which the following two cases are distinguished:

if the numbers of sharp edges are the same around the two vertices, the vertex resulting from the merger is placed in the middle of the segment linking the vertices (42, 44);

if the numbers of sharp edges are different, the vertex resulting from the merger is placed on the vertex with the greatest number of sharp edges (43, 45). **Hoppe** '744 teaches the step of pseudo-optimization comprises a step of enumerating the sharp edges around the two vertices forming the edge to be merged and a step of positioning the resulting vertex, in which the following two cases are distinguished:

if the numbers of sharp edges are the same around the two vertices, the vertex resulting from the merger is placed in the middle of the segment linking the vertices (42, 44);

if the numbers of sharp edges are different, the vertex resulting from the merger is placed on the vertex with the greatest number of sharp edges (43, 45) (CL29, L42-54), because that will

preserve the discontinuity curves (CL29, L56-58) and as per **Hoppe** that will reduce the amount of error with respect to more detailed mesh (CL8, L48-49). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Hoppe** '744 that included the step of pseudo-optimization comprising a step of enumerating the sharp edges around the two vertices forming the ewe distinguished:

if the numbers of sharp edges were the same around the two vertices, the vertex resulting from the merger was placed in the middle of the segment linking the vertices (42, 44);

if the numbers of sharp edges were different, the vertex resulting from the merger was placed on the vertex with the greatest number of sharp edges (43, 45). The artisan would have been motivated because that would preserve the discontinuity curves and that would reduce the amount of error with respect to more detailed mesh.

14. Claims 3-, 7 and 20-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Hoppe** (U.S. Patent 6,426,750) in view of **Gueziec** (U.S. Patent 6,275,233), and further in view of **Touma et al.** (U.S. Patent 6,167,159) and **Cowsar et al.** (U.S. Patent 6,285,372).

14.1 As per claim 3, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 1. **Hoppe** teaches that the method comprises a step for the selection of an edge merger to be made among all the edge mergers possible (CL9, L31-41).

Hoppe does not expressly teach a step for the selection of an edge merger to be made among all the edge mergers possible, taking account of at least one piece of information representing the curvature defined locally around the edge considered. **Cowsar et al.** teaches a

step for the selection of an edge merger to be made among all the edge mergers possible, taking account of at least one piece of information representing the curvature defined locally around the edge considered (CL7, L42-54), because that will allow replacing the vertices by a priority queue based on curvature information and other geometric and topological information (CL7, L41-42; CL7, L21-23). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Cowsar et al.** that included a step for the selection of an edge merger to be made among all the edge mergers possible, taking account of at least one piece of information representing the curvature defined locally around the edge considered. The artisan would have been motivated because that would allow replacing the vertices by a priority queue based on curvature information and other geometric and topological information.

Hoppe does not expressly teach a step for the selection of an edge merger to be made among all the edge mergers possible, taking account of at least one piece of information representing the geometrical dynamics defined locally. **Gueziec** teaches a step for the selection of an edge merger to be made among all the edge mergers possible, taking account of at least one piece of information representing the geometrical dynamics defined locally (CL10, L9-13), because that will allow a simplification technique using a priority queue based on a key that is based on the length of the edge plus sum of the error values associated with the vertices of the given edge (CL3, L10-14; CL10, L9-13). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Gueziec** that included a step for the selection of an edge merger to be made among all the edge mergers possible, taking account of at least one piece of information representing the geometrical

dynamics defined locally. The artisan would have been motivated because that would allow a simplification technique using a priority queue based on a key that was based on the length of the edge plus sum of the error values associated with the vertices of the given edge.

14.2 As per claim 4, **Hoppe, Gueziec, Touma et al.** and **Cowsar et al.** teach the method of claim 3.

Hoppe does not expressly teach the step of selection implements a queue of priorities of edges to be merged as a function of a priority criterion, the information representing the curvature. **Cowsar et al.** teaches the step of selection implements a queue of priorities of edges to be merged as a function of a priority criterion, the information representing the curvature (CL7, L42-54), because that will allow replacing the vertices by a priority queue based on curvature information and other geometric and topological information (CL7, L41-42; CL7, L21-23). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Cowsar et al.** that included the step of selection implements a queue of priorities of edges to be merged as a function of a priority criterion, the information representing the curvature. The artisan would have been motivated because that would allow replacing the vertices by a priority queue based on curvature information and other geometric and topological information.

Hoppe does not expressly teach the step of selection implements a queue of priorities of edges to be merged as a function of a secondary criterion, the information representing the geometrical dynamics. **Gueziec** teaches the step of selection implements a queue of priorities of edges to be merged as a function of a secondary criterion, the information representing the

geometrical dynamics (CL10, L9-13), because that will allow a simplification technique using a priority queue based on a key that is based on the length of the edge plus sum of the error values associated with the vertices of the given edge (CL3, L10-14; CL10, L9-13). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Gueziec** that included the step of selection implements a queue of priorities of edges to be merged as a function of a secondary criterion, the information representing the geometrical dynamics. The artisan would have been motivated because that would allow a simplification technique using a priority queue based on a key that was based on the length of the edge plus sum of the error values associated with the vertices of the given edge.

14.3 As per claim 5, **Hoppe, Gueziec, Touma et al.** and **Cowsar et al.** teach the method of claim 4.

Hoppe does not expressly teach the selection step manages a threshold of curvature, only the edges with a curvature below the threshold being considered for the application of the secondary criterion, the threshold being raised when there is no longer any edge having a curvature below this threshold. **Cowsar et al.** teaches the selection step manages a threshold of curvature, only the edges with a curvature below the threshold being considered for the application of the secondary criterion, the threshold being raised when there is no longer any edge having a curvature below this threshold (CL10, L64-65), because that will allow preserving certain features of the original mesh (CL10, L22-24). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Cowsar et al.** that included the selection step managing a threshold of curvature,

only the edges with a curvature below the threshold being considered for the application of the secondary criterion, the threshold being raised when there was no longer any edge having a curvature below this threshold. The artisan would have been motivated because that would allow preserving certain features of the original mesh.

14.4 As per claim 7, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 1.

Hoppe teaches that the decimation is interrupted as a function of one of the criteria belonging to the group comprising a geometrical complexity achieved, expressed by a number of vertices or faces (CL8, L34-37; CL8, L47-56; CL15, L43-46; CL8, L62-65).

Hoppe does not expressly teach that the decimation is interrupted as a function of one of the criteria belonging to the group comprising a compression rate achieved. **Touma et al.** teaches that the decimation is interrupted as a function of one of the criteria belonging to the group comprising a compression rate achieved (CL1, L41-50; CL3, L37-43), because that will allow compressing the mesh data as best possible before data transfer through a network, so more data can be transferred in a given time (CL1, L41-42; CL7, L21-23). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Touma et al.** that included that the decimation being interrupted as a function of one of the criteria belonging to the group comprising a compression rate achieved. The artisan would have been motivated because that would allow compressing the mesh data as best possible before data transfer through a network, so more data could be transferred in a given time.

Hoppe does not expressly teach that the decimation is interrupted as a function of one of the criteria belonging to the group comprising a threshold of curvature achieved. **Cowsar et al.** teaches that the decimation is interrupted as a function of one of the criteria belonging to the group comprising a threshold of curvature achieved (CL10, L64-65), because that will allow preserving certain features of the original mesh (CL10, L22-24). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Cowsar et al.** that included that the decimation being interrupted as a function of one of the criteria belonging to the group comprising a threshold of curvature achieved. The artisan would have been motivated because that would allow preserving certain features of the original mesh.

14.5 As per claim 20, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 10.

Hoppe teaches that the method comprises a step of limitation of the deterioration due to an elementary conversion (CL8, L47-56).

Hoppe does not expressly teach implementing a priority queue on the elementary conversions. **Cowsar et al.** teaches implementing a priority queue on the elementary conversions (CL7, L21-23; CL7, L42-54), because that will allow replacing the vertices by a priority queue based on curvature information and other geometric and topological information (CL7, L41-42; CL7, L21-23). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Cowsar et al.** that included implementing a priority queue on the elementary conversions. The artisan

would have been motivated because that would allow replacing the vertices by a priority queue based on curvature information and other geometric and topological information.

Per claim 21: **Hoppe** teaches the step of limitation of the deterioration due to an elementary conversion (CL8, L47-56); namely an edge merger, defined by two vertices (CL8, L31-37; CL8, L62-62); comprises the steps of computing a cost for each possible elementary conversion; carrying out the lowest cost elementary conversion; recomputing the costs of the elementary conversions modified by the previous elementary conversion; and adding the new elementary conversions created and computing the corresponding costs (CL8, L47-56; CL8, L34-37).

Per claim 22: **Hoppe** teaches the cost of an elementary conversion (T_i) is expressed by $C(T_i (X_i,X_j)) = \max d_2 (V_M,F(X_i^f))$ (CL8, L47-56); with:

T_i conversion merging two vertices X_i and X_j of the simplified mesh M' (CL16, L39-42);

X_i^f the vertex of the simplified mesh M' resulting from the conversion (CL8, L34-37);

$F(X_i^f)$ the faces of the simplified mesh M' neighboring the vertex X_i^f after the conversion (CL16, L9-11; CL16, L1-3);

V_M set of the vertices of the source mesh M belonging to the faces having been intersected during the computation of the orientation of the surfaces during the minimization (CL16, L9-11; CL16, L1-3; CL16, L65-67).

15. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Hoppe** (U.S. Patent 6,426,750) in view of **Gueziec** (U.S. Patent 6,275,233), and further in view of **Touma et al.** (U.S. Patent 6,167,159), **Drucker et al.** (U.S. Patent 5,736,987) and **Isaacs** (U.S. Patent 5,894,308).

15.1 As per claim 6, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 1.

Hoppe does not expressly teach the information representing the geometrical dynamics belongs to the group comprising the length of the edge considered. **Gueziec** teaches the information representing the geometrical dynamics belongs to the group comprising the length of the edge considered (CL10, L9-13), because that will allow a simplification technique using a priority queue based on a key that is based on the length of the edge plus sum of the error values associated with the vertices of the given edge (CL3, L10-14; CL10, L9-13). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Gueziec** that included the information representing the geometrical dynamics belonging to the group comprising the length of the edge considered. The artisan would have been motivated because that would allow a simplification technique using a priority queue based on a key that was based on the length of the edge plus sum of the error values associated with the vertices of the given edge.

Hoppe does not expressly teach the information representing the geometrical dynamics belongs to the group comprising a mean of the surfaces of the faces neighboring the edge considered; and a combination of the lengths of edges and/or surfaces of faces. **Drucker et al.** teaches the information representing the geometrical dynamics belongs to the group comprising a

mean of the surfaces of the faces neighboring the edge considered; and a combination of the lengths of edges and/or surfaces of faces (CL5, L22-24; CL5, L41-45), because that will allow rendering objects such that the object appears to have a smooth, continuous surface (CL7, L41-42; CL7, L21-23). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Drucker et al.** that included the information representing the geometrical dynamics belonging to the group comprising a mean of the surfaces of the faces neighboring the edge considered; and a combination of the lengths of edges and/or surfaces of faces. The artisan would have been motivated because that would allow rendering objects such that the object appears to have a smooth, continuous surface.

Hoppe does not expressly teach the information representing the geometrical dynamics belongs to the group comprising a mean of the lengths of the edges adjacent to the vertices forming the edge considered. **Isaacs** teaches the information representing the geometrical dynamics belongs to the group comprising a mean of the lengths of the edges adjacent to the vertices forming the edge considered (CL3, L39-46), because that will allow replacing the edges having shorter length than a predetermined length using vertices having longest average connected edge length (CL3, L15-18; CL3, L39-46). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Isaacs** that included the information representing the geometrical dynamics belonging to the group comprising a mean of the lengths of the edges adjacent to the vertices forming the edge considered. The artisan would have been motivated because that would allow

replacing the edges having shorter length than a predetermined length using vertices having longest average connected edge length.

16. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Hoppe** (U.S. Patent 6,426,750) in view of **Gueziec** (U.S. Patent 6,275,233), and further in view of **Touma et al.** (U.S. Patent 6,167,159), and **Farina et al.** ("A self-normalizing gradient search adaptive array algorithm", IEEE 1991).

16.1 As per claim 14, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 11.

Hoppe does not expressly teach that the step of minimization implements an adaptive gradient method. **Farina et al.** teaches that the step of minimization implements an adaptive gradient method (Page 901, CL2, Para 2 and 3), because the adaptive gradient search algorithm does not require knowledge of initial vector (Page 901, CL2, Para 2); and the required computation is simple and suitable for real-time applications and provide nearly optimum results (Page 905, CL1, Para 2). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Farina et al.** that included the step of minimization implementing an adaptive gradient method. The artisan would have been motivated because the adaptive gradient search algorithm would not require knowledge of initial vector; and the required computation would be simple and suitable for real-time applications and would provide nearly optimum results.

17. Claim 17 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Hoppe** (U.S. Patent 6,426,750) in view of **Gueziec** (U.S. Patent 6,275,233), and further in view of **Touma et al.** (U.S. Patent 6,167,159), and **Zhu et al.** (U.S. Patent 6,236,738).

17.1 As per claim 17, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 10.

Hoppe does not expressly teach that the simplified mesh is parametrized by means of a model of finite elements. **Zhu et al.** teaches that the simplified mesh is parametrized by means of a model of finite elements (CL1, L52-64), because that allows an object undergoing motion to be modeled as a dynamic finite element mesh and the deformation of the mesh being computed as a function of time (CL1, L52-56). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Zhu et al.** that included the simplified mesh being parametrized by means of a model of finite elements. The artisan would have been motivated because that would allow an object undergoing motion to be modeled as a dynamic finite element mesh and the deformation of the mesh being computed as a function of time.

Per claim 18: **Hoppe** teaches that the finite elements are advantageously obtained by means of a refined interpolator (CL10, L9-14; CL16, L35-42).

18. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Hoppe** (U.S. Patent 6,426,750) in view of **Gueziec** (U.S. Patent 6,275,233), and further in view of **Touma et**

al. (U.S. Patent 6,167,159), **Zhu et al.** (U.S. Patent 6,236,738) and **Li et al.** (U.S. Patent 6,262,737).

18.1 As per claim 23, **Hoppe, Gueziec** and **Touma et al.** teach the method of claim 1.

Hoppe does not expressly teach application of the method for the encoding of a source mesh to the field of virtual reality. **Li et al.** teaches application of the method for the encoding of a source mesh to the field of virtual reality (CL1, L50-66; CL1, L17-20), because the three-dimensional graphic models in virtual reality are presented as complex polyhedral meshes; these are expensive to render; to reduce the storage requirements and transmission bandwidth, it is desirable to compress these models with lossy compression methods which keep the distortion within tolerable limits while maximizing data reduction (CL1, L52-56). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Li et al.** that included application of the method for the encoding of a source mesh to the field of virtual reality. The artisan would have been motivated because the three-dimensional graphic models in virtual reality would be presented as complex polyhedral meshes; these would be expensive to render; to reduce the storage requirements and transmission bandwidth, it would be desirable to compress these models with lossy compression methods which would keep the distortion within tolerable limits while maximizing data reduction.

Hoppe does not expressly teach application of the method for the encoding of a source mesh to the fields of scientific simulation and modelling. **Zhu et al.** teaches application of the method for the encoding of a source mesh to the fields of scientific simulation and modelling

(CL1, L52-64), because that allows an object undergoing motion to be modeled as a dynamic finite element mesh and the deformation of the mesh being computed as a function of time, thus simulating the motion of the object (CL1, L52-56; CL4, L38-39). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Hoppe** with the method of **Zhu et al.** that included application of the method for the encoding of a source mesh to the fields of scientific simulation and modelling. The artisan would have been motivated because that would allow an object undergoing motion to be modeled as a dynamic finite element mesh and the deformation of the mesh being computed as a function of time thus simulating the motion of the object.

Conclusion

19. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 703-305-0043. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on (703) 305-9704. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-9600.

K. Thangavelu
Art Unit 2123
July 23, 2004

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER